Antigen presentation pathways

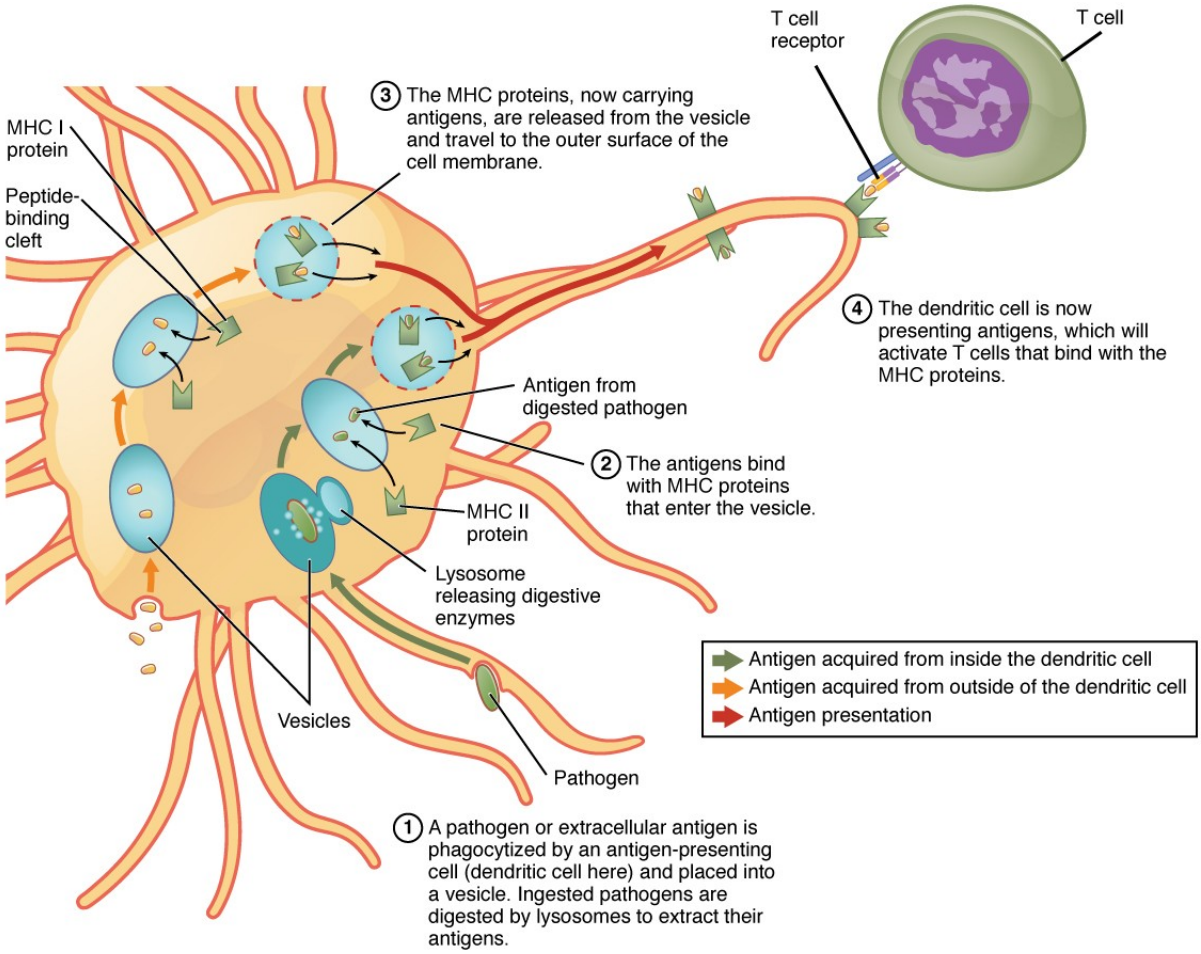
Innate immune responses are maintained in part by professional antigen presenting cells (APCs) such as dendritic cells, monocytes/macrophages and B cells. They process and display foreign and tumorigenic molecules (antigens) on their surface and interact with antigen-specific cells to link innate and adaptive immune responses.

Although antigen presentation of digested peptides is mainly considered in the context of T cells, it has been recognised that antigen presentation to B cells, which recognise their cognate antigen in its native form, plays an essential role in the generation of effective adaptive responses.

In this section, you will learn more about the molecules involved in antigen processing and presentation as well as the diseases associated with the polymorphisms (variations) within these molecules.

Take a closer look at the figure below demonstrating the antigen uptake and display by an antigen presenting cell, in this case a dendritic cell.

Notice the different routes in which various antigen peptides (epitopes) can be processed and presented to a T cell.


T cell receptor
T cell
3 The MHC proteins, now carrying antigens, are released from the vesicle and travel to the outer surface of the cell membrane.
MHC I protein
Peptide-binding cleft
4 The dendritic cell is now presenting antigens, which will activate T cells that bind with the MHC proteins.
Antigen from digested pathogen
2 The antigens bind with MHC proteins that enter the vesicle.
MHC II protein
Lysosome releasing digestive enzymes
Antigen acquired from inside the dendritic cell
Antigen acquired from outside of the dendritic cell
Antigen presentation
Vesicles
Pathogen
1 A pathogen or extracellular antigen is phagocytized by an antigen-presenting cell (dendritic cell here) and placed into a vesicle. Ingested pathogens are digested by lysosomes to extract their antigens.

An antigen presenting cell, here a large dendritic cell, encounters a

pathogen or extracellular antigen. In the first pathway, the antigen is acquired from inside the dentritic cell by one of its "tentacles". It is phagocytosed and placed into a vesicle. This is an envelope enclosed by a lipid bilayer. These ingested pathogens are digested by lysosomes within the dendritic cell. The lysosomes release digestive enzymes to digest the antigens. MHC Class 2 proteins enter the vesicle and bind to the the antigens from the digested pathogen. In the second pathway, antigens are present outside the dendritic cell aready, so once in a vesicle, they do not need digesting by lysosomes first. Here MHC Class 1 proteins bind to this antigen type, via their peptide-binding cleft. Both pathways now come together. The MHC proteins, both carrying antigens, are released from the vesicles. They travel to the outer surface of the cell membrane, along a "tentacle". The dendritic cell will now present antigens to T cells. They will activate the T cells that bind with the MHC proteins via their T cell receptors.

Source: "Antigen Processing and Presentation" in Anatomy and Physiology, OpenStax College, CC BY 4.0.

In the next three pages, you will now watch three micro-lectures which explore details of the mechanisms involved in antigen presentation and their role for the human immune system.

In the first micro-lecture, you will learn more about the characteristics of peptide antigens, the mechanisms involved in their processing and MHC I involvement.

In the second micro-lecture, you will look further at the variations within MHC I and MHC II molecules and their effect on disease susceptibility.

And in the third and final micro-lecture, you will explore the differences between MHC I and MHC II molecules, class II isotypes and HLA disease associations.

These micro-lectures are presented by Professor Danny Altmann, Professor of Immunology at Imperial College London